



**U.S. Army Aviation Life Support Equipment Retrieval  
Program: U.S. Army Aircrew Rescue and  
Factors Delaying Rescue  
(Reprint)**

**By**

**James E. Bruckart**

**Aircrew Protection Division**

**19960729 010**

**May 1996**

**DTIC QUALITY INSPECTED 3**

**Approved for public release; distribution unlimited.**

**U.S. Army Aeromedical Research Laboratory  
Fort Rucker, Alabama 36362-0577**

## Notice

### Qualified requesters

Qualified requesters may obtain copies from the Defense Technical Information Center (DTIC), Cameron Station, Alexandria, Virginia 22314. Orders will be expedited if placed through the librarian or other person designated to request documents from DTIC.

### Change of address

Organizations receiving reports from the U.S. Army Aeromedical Research Laboratory on automatic mailing lists should confirm correct address when corresponding about laboratory reports.

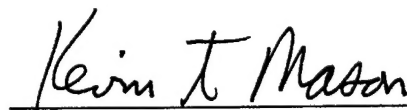
### Disposition

Destroy this document when it is no longer needed. Do not return it to the originator.

### Disclaimer

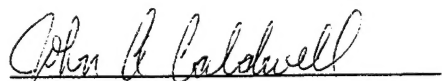
The views, opinions, and/or findings contained in this report are those of the author(s) and should not be construed as an official Department of the Army position, policy, or decision, unless so designated by other official documentation. Citation of trade names in this report does not constitute an official Department of the Army endorsement or approval of the use of such commercial items.

Reviewed:

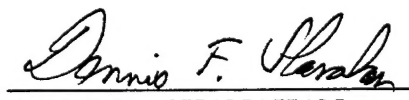


KEVIN T. MASON  
LTC(P), MC, MFS  
Director, Aircrew Protection  
Division

Released for publication:



JOHN A. CALDWELL, Ph.D.  
Chairman, Scientific Review  
Committee



DENNIS F. SHANAHAN  
Colonel, MC, MFS  
Commanding

Unclassified

SECURITY CLASSIFICATION OF THIS PAGE

| <b>REPORT DOCUMENTATION PAGE</b>  |       |  |   | Form Approved<br>OMB No. 0704-0188    |                                   |  |
|---|-------|--|---|---------------------------------------|-----------------------------------|--|
| 1a. REPORT SECURITY CLASSIFICATION<br>Unclassified  |       |  | 1b. RESTRICTIVE MARKINGS  |                                       |                                   |  |
| 2a. SECURITY CLASSIFICATION AUTHORITY   |       |  | 3. DISTRIBUTION / AVAILABILITY OF REPORT<br>Approved for public release, distribution unlimited   |                                       |                                   |  |
| 2b. DECLASSIFICATION / DOWNGRADING SCHEDULE   |       |  |   |                                       |                                   |  |
| 4. PERFORMING ORGANIZATION REPORT NUMBER(S)<br>USAARL Report No. 96-24  |       |  | 5. MONITORING ORGANIZATION REPORT NUMBER(S)   |                                       |                                   |  |
| 6a. NAME OF PERFORMING ORGANIZATION<br>U.S. Army Aeromedical Research Laboratory  |       | 6b. OFFICE SYMBOL<br>(If applicable)<br>MCMR-UAD | 7a. NAME OF MONITORING ORGANIZATION<br>U.S. Army Medical Research and Materiel Command  |                                       |                                   |  |
| 6c. ADDRESS (City, State, and ZIP Code)<br>P.O. Box 620577<br>Fort Rucker, AL 36362-0577  |       |  | 7b. ADDRESS (City, State, and ZIP Code)<br>Fort Detrick<br>Frederick, MD 21702-5012   |                                       |                                   |  |
| 8a. NAME OF FUNDING / SPONSORING ORGANIZATION   |       | 8b. OFFICE SYMBOL<br>(If applicable)             | 9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER   |                                       |                                   |  |
| 8c. ADDRESS (City, State, and ZIP Code)   |       |  | 10. SOURCE OF FUNDING NUMBERS   |                                       |                                   |  |
|   |       |  | PROGRAM<br>ELEMENT NO.<br>62787A  | PROJECT<br>NO.<br>30162787A878        | TASK<br>NO.<br>EC                 | WORK UNIT<br>ACCESSION NO.<br>DA0G0167 |
| 11. TITLE (Include Security Classification)<br>Peacetime U.S. Army aircrew rescue and factors delaying rescue (Reprint)   |       |  |   |                                       |                                   |  |
| 12. PERSONAL AUTHOR(S)<br>James E. Bruckart   |       |  |   |                                       |                                   |  |
| 13a. TYPE OF REPORT<br>Final  |       | 13b. TIME COVERED<br>FROM TO                     |   | 14. DATE OF REPORT (Year, Month, Day) |                                   |  |
| 15. PAGE COUNT  |       |  |   |                                       |                                   |  |
| 16. SUPPLEMENTAL NOTATION<br>Published in the February 1992 issue of Aviation, Space, and Environmental Medicine.   |       |  |   |                                       |                                   |  |
| 17. COSATI CODES  |       |  | 18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number)<br>search and rescue, aircraft mishap, crashworthiness, postcrash |                                       |                                   |  |
| FIELD   | GROUP | SUB-GROUP  |   |                                       |                                   |  |
|   |       |  |   |                                       |                                   |  |
|   |       |  |   |                                       |                                   |  |
| 19. ABSTRACT (Continue on reverse if necessary and identify by block number)<br>Despite strict flight discipline, U.S. Army aircraft infrequently suffer inflight mishaps. This is a retrospective study of aircrew survival and rescue in 97 mishaps investigated by the U.S. Army Safety Center from October 1988 to June 1990. To identify factors delaying rescue, later mishaps were compared with 37 mishaps where the time to reach the mishap site exceeded 2 hours. The average time to reach a mishap site was 2.2 hours, but over 90 percent were reached within 2 hours. There were two or more survivors at 82 percent of the sites, and 98 percent of the downed aircrew had at least personal survival equipment available.<br><br>Adverse operational and environmental factors were more common in delayed rescue mishaps. Sudden aircraft failure was three times more common in prolonged rescue mishaps, while night or instrument meteorologic conditions contributed eight times and four times greater risk of delay, respectively. Rescues in mountainous terrain or over water were seven times more likely to be delayed. While fatalities were more common with prolonged rescue, there were no mishaps where a delay in reaching the crash site resulted in loss of life. |       |  |   |                                       |                                   |  |
| 20. DISTRIBUTION / AVAILABILITY OF ABSTRACT<br><input checked="" type="checkbox"/> UNCLASSIFIED/UNLIMITED <input type="checkbox"/> SAME AS RPT. <input type="checkbox"/> DTIC USERS   |       |  | 21. ABSTRACT SECURITY CLASSIFICATION<br>Unclassified  |                                       |                                   |  |
| 22a. NAME OF RESPONSIBLE INDIVIDUAL<br>Chief, Science Support Center  |       |  | 22b. TELEPHONE (Include Area Code)<br>(334) 255-6907  |                                       | 22c. OFFICE SYMBOL<br>MCMR-UAX-SS |  |

## Contents

|                    | Page |
|--------------------|------|
| Introduction ..... | 3    |
| Methods .....      | 3    |
| Results .....      | 5    |
| Discussion .....   | 7    |
| Summary .....      | 8    |
| References .....   | 9    |

## List of figures

| Figure   | Page |
|--|------|
| 1. Number of survivors at each mishap site ..... | 6    |

## List of tables

| Table  |   |
|--|---|
| 1. Definition of U.S. Army class A-E mishaps .....   | 4 |
| 2. Comparison of adverse factors among normal rescue mishaps and<br>mishaps requiring greater than 2 h to rescue ..... | 7 |

### Acknowledgment

This report has been published previously in Aviation, Space, and Environmental Medicine, Volume 63, No. 2, February 1992, under the title "Peacetime U.S. Army Aircrew Rescue and Factors Delaying Rescue."

## Introduction

The U.S. Army trains aviation personnel to the highest standards, provides well-maintained aircraft, and practices prudent flight rules, but occasionally an aircraft suffers a mechanical failure or human factor related mishap. If the unplanned termination of the flight is not near the origin or destination airfield, then a search must be initiated to locate the aircraft.

Five factors have been linked to survivability in aircraft accidents: Crashworthiness, restraint, environment, energy absorption, and postcrash factors. DeHart and Beers (1985) emphasize the importance of rapid search and rescue to preserve life. In this study, among 607 accident survivors, successful recovery was time-dependent. Of the survivors, 68 percent were recovered in the first 24 hours and 75 percent recovered within 48 hours. The life expectancy of injured survivors decreases by up to 80 percent after the first 24 hours and the survival of uninjured survivors diminishes rapidly after 3 days. If the rescue is delayed beyond 2 days, then the overall rate drops to less than 10 percent. Adverse weather and darkness were important factors influencing recovery times (DeHart and Beers, 1985).

U.S. Army aircraft fly assigned missions, and flight plans are used to follow the flight to successful termination. The unit is alerted and search procedures are immediately initiated if a flight is reported in distress or overdue. As a result, most Army aircrew are rescued or recovered soon after a mishap.

This is a retrospective study of the recent U.S. Army experience at the mishap site and aircrew rescue. First, it examines the likely number of survivors and survival equipment at the mishap site. Second, the time interval from the mishap to the arrival of rescue personnel is reviewed. Finally, a second group of mishaps, in which the time to reach the accident exceeded 2 hours, is compared with the normal experience to identify factors that may be associated with delays in reaching a mishap site.

Flight surgeons, commanders, and individual airmen will find this information helpful in evaluating missions that may be associated with delay in reaching a downed aircraft. These missions require special attention to survival equipment and aircrew survival training.

## Methods

### Mishap data

The U.S. Army Safety Center at Fort Rucker, Alabama, investigates most U.S. Army aircraft accidents and collects specific information on all accidents to prevent their recurrence. The mishaps are grouped from Class A to E according to the aircraft damage and injuries to personnel as summarized in Table 1. A synopsis of all U.S. Army Class A, B, and C aviation accidents from October 1988 to June 1990 was obtained from the U.S. Army Safety Center.

Table 1.  
Definition of U.S. Army Class A-E mishaps in 1990.

| Class | Includes any of the following:  |
|-------|---|
| A     | Loss of life or permanent total disability of a crewman<br>Total loss of an aircraft<br>Damage in excess of \$1,000,000 |
| B     | Permanent partial disability of a crewman<br>Damage between \$200,000 and \$999,999                                     |
| C.    | Temporary disability of a crewman in excess of the duty day<br>Damage between \$10,000 and \$199,999                    |
| D     | Damage between \$2000 and \$9999  |
| E     | Damage < \$2000   |

Among this group of 216 mishaps, 97 were selected for study because they included a human factors evaluation. This evaluation includes what survival equipment was available at the mishap site and the time to reach the downed aircrew. U.S. Army aircraft involved in the mishaps included UH-1, UH-60, OH-58, AH-1, and AH-64 helicopters, and OV-1, U-21, and C-12 fixed-wing aircraft. The mishaps that were not studied involved mechanical failures during run-up and ground handling mishaps where no injuries occurred and aircrew survival investigation was not performed. Each of the 97 accident briefs includes the type of aircraft, survival equipment, time for rescue personnel to reach the mishap site, and a 100-word narrative summary describing the accident. The time to reach the mishap site is used synonymously with the rescue time in this report.

The mishap summaries were evaluated to determine the number of survivors at each mishap site and the type of survival equipment available. Finally, the average time required for rescue personnel to reach the downed aircraft was checked.

#### Comparison data

Initial review of the U.S. Army rescue experience showed that most mishap sites were reached quickly. A comparison group of mishaps, in which there was a delay in reaching the aircrew, was selected to investigate factors associated with delays in reaching downed aircrew. The comparison group includes 37 mishaps that occurred between January 1980 and June 1990. There are all Class A, B, or C accidents from the U.S. Army Safety Center in which the time to reach the mishap exceeded 2 hours. Notably, this represents less than 4 percent of the mishaps that occurred during the period.

## Assessment of relative risk

The narrative summary from each accident brief was reviewed to determine if adverse environmental conditions, specific adverse crash factors, or fatalities were present. Adverse environmental conditions included Instrument Meteorologic Conditions (IMC), night, over-water, or mountainous terrain. Note also was made if a sudden aircraft failure prevented radio calls for assistance prior to impact. These sudden factors included catastrophic engine failures, wire strikes, and tail rotor failures.

The frequency of each adverse condition was checked for the recent mishap group and comparison group where time to reach the aircrew exceeded 2 hours. The frequency of the adverse condition in each group was used to form a 2x2 table. This compares the presence of the factor in normal and >2-hour rescue groups. The relative risk was approximated by calculating the odds ratio for each adverse condition. A Chi-square value was used to assess the probability of a difference in the associated factor between normal and >2-hour rescue groups (Armitage and Berry, 1987; Mausner and Kramer, 1985).

## Results

### Time to reach the mishap site

U.S. Army aircrew were reached quickly after a mishap. The average time required to reach a downed aircrew was 2.2 hours due to a few very long rescue times, but over 90 percent of the mishap sites were reached in much less than 2 hours. There were no mishaps where a delay in reaching the crash site resulted in the loss of an airman.

### Number of survivors and survival equipment

Most Army aircraft are flown with at least a two-person crew, while transport and medevac helicopters may fly with a four-person crew. This contributes to the finding of two or more survivors at many mishap sites as detailed in Figure 1.

Each crewmember wears a personal survival vest, and additional survival equipment frequently is carried in the aircraft when flying over water or over hazardous terrain. As a result, personal survival equipment should be available at each mishap site. The human factors evaluation of these mishaps confirmed that survival equipment, either a personal survival vest or survival kit, was present at 98 percent of the mishap sites.

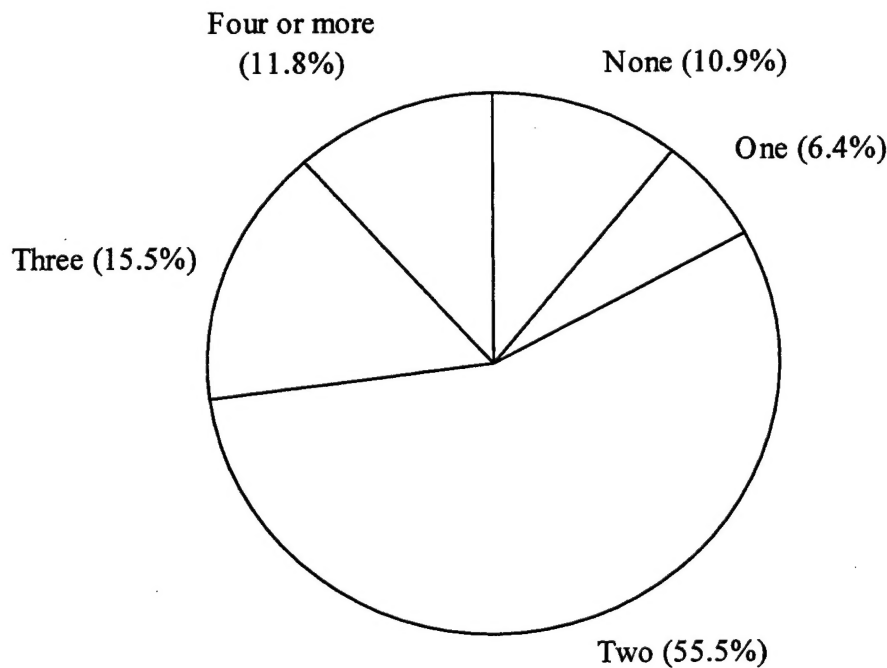


Figure 1. Number of survivors at each mishap site.

#### Adverse factors associated with prolonged rescue

Overall, less than 2 hours were required to reach most downed aircrew. Sudden aircraft failures, environmental factors, and fatalities were found more frequently in the mishaps requiring 2 or more hours to reach the mishap site as noted in Table 2. Sudden aircraft failures were three times more common in the >2-hour rescue group.

If the mishap occurred at night, it was eight times more likely that the rescue would be delayed compared to a daytime mishap. If the mishap occurred in adverse weather, including Instrument Meteorologic Conditions (IMC) or below minimums, the rescue was four times more likely to require more than 2 hours.

Over water mishaps were seven times more likely than land accidents to result in greater than 2-hour rescue. In addition, if the mishap occurred in mountainous terrain, it was six times more commonly associated with prolonged rescue.

Fatalities also were found 3.5 times more commonly in accidents where the time to reach the mishap site exceeded 2 hours. Most likely, this is an indirect effect, since no mishap summary discussed a loss-of-life from prolonged rescue.

Table 2.  
Comparison of adverse factors among normal rescue  
mishaps and mishaps requiring greater  
than 2 hours to rescue.\*

| Adverse factor          | All mishaps (N = 97) | Rescue >2 hours (N = 97) | Odds ratio | X <sup>2</sup> | p      |
|-------------------------|----------------------|--------------------------|------------|----------------|--------|
| Sudden aircraft failure | 19                   | 15                       | 2.8        | 6.2            | <0.025 |
| Night                   | 7                    | 14                       | 7.8        | 19.0           | <0.001 |
| IMC or fog              | 6                    | 8                        | 4.2        | 6.8            | <0.01  |
| Mountainous terrain     | 7                    | 12                       | 6.2        | 14.0           | <0.001 |
| Over water              | 3                    | 7                        | 7.3        | 9.7            | <0.01  |
| Fatality                | 19                   | 17                       | 3.5        | 9.4            | <0.01  |

### Discussion

Most U.S. Army aircraft are reached promptly after a mishap and the Army experience is better markedly than the civilian experience reported by DeHart and Beers (1985). Likely explanations include the widespread use of flight plans and the military organization available to promptly initiate a search for an overdue aircraft. For comparison, in 1982 the FAA General Aviation Activity and Avionics Survey reported that flight plans are used for only 18 percent of general aviation flights. The rapid overall rescue of Army aircrew resulted in the finding of no fatalities from delays in aircrew rescue for the 20-month period.

The widespread use of the survival vest means some signal and survival materials were available to assist the downed aircrew. The U.S. Army rescue experience supports the U.S. Navy and Marine Corps policy requiring man-carried survival items for the first 6 hours supplemented by stowed survival items for the first 24 hours (Gillespie and Sloane, 1987). In addition, the U.S. Army currently is fielding a new survival radio (AN/PRC-112) with increased range and tracking abilities that may further decrease rescue time in the future (Chowen, 1990).

Two or more survivors were present at a mishap location in over 70 percent of the mishaps studied. If there are two or more survivors, then several survival tasks, such as signal and firemaking, can be completed at once. In addition, an injured person is likely to have another crewmember available to provide assistance pending rescue. These factors may improve the chance of survival for each individual.

In those mishaps where there was a delay in rescue, both operational and environmental factors contributed to delays in reaching the mishap site. Most of the Army accidents occurred in helicopters where sudden aircraft or system failure usually results in immediate termination of the flight. In the mishaps with delayed rescue, there was no time for a "Mayday" call prior to landing.

The presence of night and significant weather make locating and reaching the mishap site difficult. Both factors also were found to delay rescue in civilian accidents.

If the mishap occurs in mountainous terrain, survivors are more likely to be isolated or in difficult terrain. This may be expected to slow rescue personnel and delay their arrival at the mishap site. Over water flight also contributes to delays when the aircraft wreckage sinks. In this study, the single mishap requiring several days to locate the wreckage occurred over water.

The increased frequency of fatalities among delayed rescue mishaps probably is an indirect effect. In other words, there is no information to suggest that a delay caused fatalities. In fact, the operational and environmental factors that caused delays in reaching the aircrew are more likely to result in a nonsurvivable mishap.

### Summary

The U.S. Army has an excellent record in providing survival equipment for downed aircrew and reaching the mishap site quickly. There were two or more survivors present in over 70 percent of the mishaps, which may aid individual survival. If the aircraft is lost at night, in adverse weather, over mountainous terrain or water, rescuers are more likely to require greater than 2 hours to reach the accident site. Commanders, mission planners, and aviators should use this guidance to emphasize preflight survival planning and identify missions likely to result in rescue delays.

### References

- Armitage, P., and Berry, G. 1987. Statistical methods in medical research. Oxford: Blackwell Scientific. 2nd ed.
- Chowen, S. H. 1990. PLS: Taking the search out of search and rescue. Aviation Digest. 1-90-5:32-3.
- DeHart, R. L., and Beers, K. N. 1985. Aircraft accidents, survival, and rescue. In: Fundamentals of aerospace medicine, DeHart, R. L., ed. Philadelphia: Lea & Febiger. 862-87.
- Gillespie, G., and Sloane, M. 1987. An update of state-of-the-art survival items for USN/USMC aircrew. In: SAFE Proceedings. Yoncalla, OR: SAFE Association.
- Mausner, J. S., and Kramer, S. 1985. Epidemiology--an introductory text. Philadelphia: W. B. Saunders.